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Air Standards and Studies

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AIR QUALITY
IN THE SHERRIDON, MANITOBA AREA
DURING JULY TO OCTOBER, 1982

A. M. Campbell, B. Sc.

Environmental Management Services.

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ABSTRACT

A study of the air quality in Sherridon, Manitoba was undertaken during July to October, 1982 as a result of concerns expressed by citizens living in the area. These concerns were related to health hazards which might arise due to breathing airborne dust from local roads constructed with waste mine tailings from the abandoned Sherritt-Gordon mine. The concentrations of total suspended particulate matter (TSP), lead (Pb), zinc (Zn), total chromium (T-Cr), cadmium (Cd), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), arsenic (As), aluminum (Al), sulphates (SO_4) and quartz (SiO_2) were measured using standard high volume samplers and/or low volume (personal) samplers (fixed locations). Air quality as determined by this testing program was found to comply both with available Manitoba air quality criteria and with criteria used by other agencies involved in air assessment.

BACKGROUND

Mine tailings from the abandoned Sherritt-Gordon mine were used in the construction of a road system for the towns of Sherridon and Cold Lake. Concern was expressed by residents of the area that airborne dust originating from the road system might be hazardous to their health.

The Sherritt-Gordon mine was closed on September 20, 1951 after 7.7×10^6 tonnes of ore had been mined from which copper and zinc were extracted leaving 6.7×10^6 tonnes of tailings. Pyrrhotite, composing about 20-24% of the tailings is the main sulphide ore in the tailings.[7] The pyrrhotite liberates hydrogen sulphide which may account for the sulphide odour reported to be noticeable from time to time along the road. The tailings provided a ready supply of material for road construction and were used for this purpose in the town of Sherridon and for the road to Cold Lake.

To test the air quality in the area, a survey was undertaken to determine the concentrations of total suspended particulate matter (TSP), lead (Pb), zinc (Zn), total chromium (T-Cr), cadmium (Cd), manganese (Mn), iron (Fe), nickel (Ni), copper (Ca), arsenic (As), aluminum (Al), sulphates (SO_4) and quartz (SiO_2). The TSP and SO_4 and all of the metals except aluminum were sampled by using standard high volume samplers while some back-up

monitoring for certain metals was carried out using a low volume (personal) sampling system at fixed locations. The low volume system sampled for the above metals except for Cu and As but included Al. In addition, certain low volume air samples were tested at the Elliot Lake laboratory of the Federal Department of Energy, Mines and Resources for quartz (SiO_2). Pollutant concentrations were compared with various air quality criteria and with air quality in different regions of the province and elswhere. Finally, two soil samples taken from the road surface were analyzed to assist in assessing the relationship between road dust contaminants and airborne contaminants.

SAMPLING PROTOCOL

The collection of air samples in this study was undertaken using two types of sampling apparatus. Most samples were collected by standard High Volume air samplers which draw large quantities of ambient air (approximately 2,000 m^3 in a 24-hour period) through a filter upon which airborne dust is collected for analysis. The total weight of the dust collected is then divided by the the total volume of air sampled over the 24-hour sampling period to generate the Total Suspended Particulate concentration (TSP). After TSP concentrations had

been determined this way, the filters were chemically analyzed to determine the quantities of metal components and sulphates. All High Volume samples were analyzed for TSP, Pb, Zn, T-Cr, Cd, Mn, Fe, Ni, Cu, As and SO_4. The operation involved running two High Volume samplers on alternate days for approximately 24 hours using Gelman type A/E glass fiber filters. Duties related to the operation of the High Volume samplers were undertaken by the mayor of the town. Difficulties with one of the samplers caused all samples in the latter part of the survey to be taken with the remaining High Volume sampler.

The low volume sampling system employed small Nioshi personal samplers (of the type used in industrial hygiene surveys) which used smaller pumps to draw 2 liters per minute through filters appropriate for either metals or quartz depending on the application. The methodology and certain equipment used to determine the quartz component followed that outlined by the Canada Center for Mineral and Energy Technology (CANMET) which undertook the sample analyses for this parameter.

SAMPLING LOCATIONS

The sampling locations for the equipment are shown in Figure 1. The two High Volume samplers were situated approximately 7 meters south-west of the rear of the Cambrian Hotel. The samplers were 15 meters from the road at the closest point and were mounted with bases at ground level with sampling ports about 1.5 meters above ground, alongside one another, 0.5 meters apart.

The Nioshi sampler at the hotel location was clipped to a wooden fence approximately 1 m closer to the road than the High Volume samplers with the sampling port about 1.5 meters above ground level.

The low volume (Nioshi) sampler at the rink location was approximately 5 meters from the road shoulder with the sampling port 15 to 20 cm. above ground level. Small shrubs, approximately 1.5 meters high, screened the view of the sampler from the road. The natural treeline was approximately 7 meters further back from the road and rose about 7 to 8 meters in height.

The soil samples were simply scooped by hand from the road surface near the edge of the travel marks on the road. The location of the samples taken is marked on Figure 1.

SAMPLING DATES

Sampling dates for the various samples are as follows:

High Volume Samples	Low Volume (Metals) Samples	Low Volume (Quartz)	Soil Samples
July 29 - 31	July 27 - 28	July 27 - 28	July 28
August 1 - 12 27, 30, 31			
September 1,2, 4,6,7,8,10-30			
October 1 - 6 14 - 16			

METHOD OF ANALYSIS

The TSP results were measured following standard gravimetric procedures while all metal and sulphate analyses were performed following the methodology outlined in the Manitoba Technical Services Laboratory's Analytical Methods Manual.[11] The quartz (SiO_2) tests were performed by the Federal Elliot Lake Laboratory at the Canada Center for Mineral and Energy Technology (CANMET) according to protocol developed by them for testing quartz content employing X-ray diffraction analysis.

METEOROLOGICAL DATA

Meteorological data was taken during the high volume test program. A compilation of this data appears in Appendix 3.

RESULTS

The results of the sampling program appear in Tables 1 through 4 inclusive. TSP values were not significant. Lead, total-chromium and nickel were not found above detectable limits in the High Volume sampling program. Cadmium showed only two results above the detectable limit while zinc, manganese and arsenic showed several samples above the detectable limit. Iron, copper and sulphates showed most or all samples above the detectable limit. Particulate values are repeated in Table 1 in order to facilitate ratio calculations if desired at some future point.

In the low volume sampling, all samples indicated metal concentrations below detectable levels except two. One sample showed levels of chromium and iron which were pronounced and unexplained (18 and 49 times the detection level respectively) while manganese and nickel were detected at 5-6 times their detection level. The other sample indicated the presence of aluminum.

The quartz analysis indicated that 2 of the 4 samples were above the detection level showing concentrations of 1.9 and 1.3 micrograms per cubic meter of air ($\mu g/m^3$) for the two positive results. These values were only slightly above the detection capabilities of the methodology used.

TABLE 1: SHERRIDON HIGH VOLUME SAMPLES RESULTS-MICROGRAMS PER CUBIC METER

All results are reported in units of micrograms per cubic meter of air ($\mu g/m^3$) as a 24 hour average.

Date	Particulate	Pb	Zn	T-Cr	Cd	Mn
7-29	9	<.033	<.007	<.016	<.003	<.007
7-30	33	<.035	<.007	<.017	<.003	.011
7-31	10	<.032	<.006	<.016	<.003	.007
8-01	6	<.035	<.007	<.018	<.004	<.007
8-02	4	<.034	<.007	<.017	<.003	<.007
8-03	7	<.033	<.007	<.017	<.003	<.007
8-04	14	<.048	<.010	<.024	<.005	<.010
8-05	8	<.041	<.008	<.021	<.004	<.008
8-06	14	<.023	<.005	<.011	<.002	.005
8-07	6	<.018	<.004	<.009	<.002	<.004
8-08	5	<.033	<.007	<.017	<.003	.007
8-09	11	<.035	<.007	<.017	<.003	.008
8-10	12	<.032	<.006	<.016	<.003	.020
8-11	25	<.024	<.005	<.012	<.002	.019
8-12	17	<.032	<.006	<.016	<.003	.014
8-27	14	<.037	<.007	<.018	<.004	.012
8-30	5	<.035	<.007	<.017	<.003	<.007
8-31	2	<.033	<.007	<.016	<.003	<.007
9-01	11	<.039	<.008	<.019	<.004	.009
9-02	15	<.047	<.009	<.023	<.005	<.009
9-04	6	<.043	<.009	<.022	<.004	.010
9-06	6	<.031	<.006	<.016	<.003	<.006
9-07	9	<.052	<.010	<.026	<.005	.012
9-08	15	<.046	<.009	<.023	<.005	.010
9-10	8	<.046	<.009	<.023	<.005	.010
9-11	7	<.030	<.006	<.015	<.003	<.006
9-12	4	<.068	<.014	<.034	<.007	<.014
9-13	9	<.045	.151	<.023	<.005	.010
9-14	15	<.030	.062	<.015	.005	.010
9-15	9	<.032	<.006	<.016	<.003	.007
9-16	7	<.032	<.006	<.016	<.003	.007
9-17	8	<.033	<.007	<.017	<.003	<.007
9-18	3	<.032	<.006	<.016	<.003	<.006
9-19	3	<.028	.119	<.014	<.003	<.006
9-20	16	<.032	.233	<.016	.006	.010
9-21	19	<.033	.041	<.017	<.003	.014
9-22	10	<.033	<.007	<.017	<.003	.008
9-23	19	<.030	.067	<.015	<.003	.013
9-24	17	<.032	<.006	<.016	<.003	.010
9-25	4	<.030	<.006	<.015	<.003	.007
9-26	--	<.041	<.008	<.020	<.004	<.008
9-27	3	<.046	.053	<.023	<.005	<.009
9-28	3	<.050	.116	<.025	<.005	<.010
9-29	--	<.035	<.007	<.018	<.004	<.007
9-30	5	<.035	.061	<.018	<.004	<.007
10-01	2	<.040	.042	<.020	<.004	<.008
10-02	--	<.041	.039	<.021	<.004	<.008
10-03	2	<.041	.035	<.021	<.004	<.008
10-04	3	<.042	.031	<.021	<.004	<.008
10-05	3	<.034	.029	<.017	<.003	<.007
10-06	2	<.039	.037	<.020	<.004	<.008
10-14	--	<.049	.052	<.025	<.005	<.010
10-15	6	<.064	.067	<.032	<.006	<.013
10-16	4	<.040	.042	<.020	<.004	<.008
Avg.	**9**	--	**<.028**	--	--	**<.009**
High	**33**	--	**.233**	--	**.006**	**.020**

Date	Particulate	Fe	Ni	Cu	As	SO_4
7-29	9	.337	<.016	.122	<.0003	.39
7-30	33	.147	<.017	.100	<.0003	1.93
7-31	10	.325	<.016	.124	<.0003	.18
8-01	6	<.044	<.018	.039	<.0004	.06
8-02	4	<.017	<.017	.095	<.0003	.06
8-03	7	.075	<.017	.027	<.0003	.19
8-04	14	<.024	<.024	.412	<.0005	.42
8-05	8	<.021	<.021	.137	<.0004	.82
8-06	14	.367	<.011	.120	<.0002	.65
8-07	6	.040	<.009	.106	<.0002	.08
8-08	5	<.017	<.017	.102	<.0003	.12
8-09	11	.354	<.017	.090	<.0003	.41
8-10	12	.515	<.016	.124	<.0003	.57
8-11	25	.664	<.012	.101	<.0002	1.01
8-12	17	.265	<.016	.106	<.0003	.70
8-27	14	.818	<.018	.166	<.0004	.65
8-30	5	<.017	<.017	.143	<.0003	.35
8-31	2	<.016	<.016	.049	<.0003	.12
9-01	11	<.019	<.019	.120	<.0004	.30
9-02	15	.105	<.023	.182	<.0005	.55
9-04	6	.054	<.022	.161	<.0004	<.04
9-06	6	.071	<.016	.088	<.0003	.31
9-07	9	.116	<.026	.072	<.0005	.40
9-08	15	.468	<.023	.205	<.0004	.90
9-10	8	.104	<.023	.009	.0040	6.41
9-11	7	.129	<.015	.088	<.0003	.54
9-12	4	.085	<.034	.122	<.0007	.25
9-13	9	.282	<.023	.144	.011	2.92
9-14	15	.310	<.015	.073	.019	5.50
9-15	9	.201	<.016	.090	.005	5.05
9-16	7	.265	<.016	.087	.003	3.27
9-17	8	.471	<.017	.059	.001	1.38
9-18	3	.135	<.016	.057	<.0003	<.03
9-19	3	.063	<.014	.059	.007	2.10
9-20	16	.522	<.016	.077	.023	5.19
9-21	19	.605	<.017	.100	.006	4.27
9-22	10	.409	<.017	.100	<.0003	.73
9-23	19	1.44	<.015	.162	.0005	1.61
9-24	17	.386	<.016	.069	.001	3.15
9-25	4	.130	<.015	.040	<.0003	1.33
9-26	--	.091	<.020	.065	<.0004	.27
9-27	3	.058	<.023	.060	<.0005	3.20
9-28	3	<.025	<.025	.084	<.0005	1.32
9-29	--	<.018	<.018	.039	<.0004	.06
9-30	5	<.018	<.018	.025	.008	3.57
10-01	2	<.020	<.020	.044	<.0004	.87
10-02	--	<.021	<.021	.049	<.0004	.36
10-03	2	<.021	<.021	.079	<.0004	2.85
10-04	3	<.021	<.021	.062	<.0004	.70
10-05	3	.076	<.017	.054	<.0003	.74
10-06	2	<.020	<.020	.063	<.0004	.78
10-14	--	.210	<.025	.035	<.0005	.09
10-15	6	.398	<.032	.127	<.0006	<.06
10-16	4	<.020	<.020	.056	<.0004	.95
Avg.	9	.212	--	.095	<.0012	1.32
High	33	1.44	--	.412	.023	6.41

Average calculated if over 20% of values above detection level.

TABLE 2. METAL CONCENTRATIONS USING LOW VOLUME SAMPLERS

All results are reported in units of micrograms per cubic meter of air ($\mu g/m^3$) as a 24 hour average.

Date	82 07 27	82 07 28	82 07 28	82 07 27	82 07 28	82 07 28
Location	Rink	Rink	Rink	Hotel	Hotel	Hotel
Time	10:45am -6:15pm	9:45am -9:15pm	9:20am -12:15pm (29th)	10:30am -11:30pm	9:30am -9:00pm	9:15pm -1.00pm (29th)
Pb	<5.2	<3.7	< 2.8	< 3.2	3.7	< 1.7
Zn	<5.2	<3.7	<2.8	<3.2	<3.7	<1.7
T-Cr	<3.2	<2.2	<1.7	<2.0	39.9	<1.0
Cd	<1.1	<.73	<.56	<.64	<.73	<.34
Al	10.5	<7.3	<5.6	<6.4	<7.3	<3.4
Mn	<1.1	<.73	<.56	<.64	3.6	<.34
Mg	<26.1	<18.1	<13.9	<16.0	<18.1	< 8.4
Fe	<6.3	<3.7	<2.8	<3.2	181	<1.7
Ni	<6.3	<3.7	<2.8	<3.2	21.8	<1.7
Vol.(m^3)	.96?	1.38	1.80	1.56	1.38	1.80

? = difficulties with the pump makes this calculation an estimate.

TABLE 3 QUARTZ CONCENTRATIONS USING LOW VOLUME SAMPLERS*

Results reported in micrograms per cubic meter of air ($\mu g/m^3$) as a 24 hour average.

Date	Location	Time	Quartz Concentration ($\mu g/m^3$)	Volume (m^3)
82 07 27	Rink	10:45 am- 6:45 pm	not detected	.96(?)
82 07 28	Rink	9:30 am-12:15 pm	1.9	3.21
82 07 27	Hotel	10:30 am-11:30 pm	1.3	1.56
82 07 28	Hotel	9:30 am- 1:00 pm	not detected	3.30

? difficulties with the pump makes this calculation an estimate.

* The Elliot Lake Laboratory uses a direct-on-filter analytical technique which requires a calibration of each type of complete sampling train which was not carried out for this train--the values are based on those obtained on the closest train on record which differed in some possibly significant components.

TABLE 4 SOIL SAMPLES

Results are reported in units of micrograms of analyte per gram of soil sample (µg/g or parts per million).

Location	Hotel	Rink	Average
Pb	60	90	75
Zn	830	900	865
Cr	18	32	25
Cd	3	4	3.5
Mn	160	220	190
Fe	6,400	7,200	6,800
Ni	10	20	15
Ca	3,500	3,800	3,650
As	16.3	19.4	17.9
SO_4	3,600	15,600	9,600

CRITERIA VALUES AND INTERPRETATION OF RESULTS

Manitoba Criteria

The TSP and lead results can be directly compared with maximum acceptable levels established for ambient air by the Province of Manitoba which are 120 micrograms per cubic meter $\mu g/m^3$ and 5 $\mu g/m^3$ respectively (as a 24-hour average). The results indicated that neither limit is exceeded. The highest TSP result is only 30% of the criteria value while lead levels were all below the detection level of the method used. Criteria which have been established or suggested by other agencies have been used to evaluate the remainder of the results for the other pollutants.

The criteria developed by these outside agencies indicates that neither the high volume samples nor the quartz samples exceed even the most stringent of guidelines. One sample in the low volume heavy metal testing indicated that chromium, iron and nickel values exceeded the Ontario 24-hour criteria (as calculated using a rule-of-thumb method). This sample is currently being viewed as an unexplained anomaly and is not considered to be indicative of concentrations which can be expected in the area. The methodology used in the low volume sampling was not routine for this purpose and the weight of the interpretation of air quality must rest rather heavily on the high volume sampling results.

VALUES FOUND IN OTHER AREAS OF THE PROVINCE AND ELSEWHERE

The Sherridon results were compared with other areas of Manitoba selected to be representative of rural (St. Laurent), intermediate (Carman), and urban (Winnipeg) sites. The concentrations at these sites over the time frame of measurement is shown in Table 9 in Appendix 2.

The following comparisons of Sherridon data to reference sites data can be made.

TSP	-essentially at the rural background level and lower than the intermediate or urban site.
Pb	-lower than the reference sites; none detected.
Zn	-no results to compare within selected comparison sites.
T-Cr	-below urban levels, no results from rural or intermediate sites.
Cd	-2 values above detectable level but these were only slightly above background at the reference sites.
Mn	-same as rural background level; below concentrations at other sites.

Fe -lower than Winnipeg 1980 results; comparative data from other sites not available.

Ni -no values at Sherridon were above detection limits.

Cu -somewhat higher than the reference sites.

As -similar to 1979 Winnipeg data, St. Laurent (rural) data, higher than 1980 Winnipeg data or Carman data.

SO_4 -lower than 1979, 1980 Winnipeg data; other sites did not have data available.

The Sherridon data was also compared with other locations:

a) In the German city of Frankfurt, the values of Cr ranged from .3 to 14.5 ng/m^3 while Ni ranged from 1.7 - 42 $(ng/m^3)^1$ (ng = nanogram meaning 10^{-12} grams). In the Sherridon study, Cr was not found at the detection level which was at the upper end of the range of the values found at Frankfurt. Nickel-in-air concentrations at Sherridon were not found above the detection level which was about half the value of the highest results found at Frankfurt.

b) Cadmium results in the Sherridon area, although rarely above the detection level, indicate concentrations at or below values found in the Lancaster area of the U.K. The Pb and SO_4 levels in the rural English study are significantly higher than those found at Sherridon.[4] These values can be seen in Table 9, Appendix 2.

SUMMARY

1. The TSP levels in the Sherridon study were significantly lower than the Manitoba air quality objectives and are similar to results found at a background rural Manitoba test site.
2. Copper showed significantly higher results in the Sherridon study than any of the Manitoba comparative test sites but values were well below air quality criteria promulgated by outside agencies.
3. Cadmium showed slight but insignificant results above Manitoba background comparison stations and was far below air quality criteria of regulatory agencies having standards for Cadmium.
4. The remaining metals and sulphates concentrations found in the Sherridon study were at or below the levels found in comparison areas and also below ambient air quality standards. The Manitoba ambient air criteria for lead of 5 $\mu g/m^3$ as a 24-hour average was not exceeded and, in fact, lead was below the detection level for all air samples from Sherridon.

5. Silica testing, carried out by the CANMET laboratory, indicated the presence of silicon dioxide (quartz) but at levels below criteria established by outside agencies.

6. The presence of arsenic and cadmium appeared to be associated with high levels of sulphates.

7. Soil samples indicated the presence of all of the contaminants found in the air samples except for aluminum which was not tested for in the soil. The soil samples showed that the highest metal concentration was iron followed by copper, zinc, and manganese. Other metals were not found at greater than .01% of the sample by weight. Soil sulphates showed an average concentration near that of iron.

CONCLUSION

It is thus concluded that the air quality in Sherridon as demonstrated by this test program is acceptable and is comparable to air quality found in other rural areas of the Province.

TABLE 5. ONTARIO SCHEDULE 1 TENTATIVE STANDARDS LIST [3,8] ($\mu g/m^3$)

	1/2 hour impingement.	24-hour average
TSP	100	---
Pb	10	3.0
Zn	100	(33)
Cr	30	(10)
Cd	5.0	(1.7)
Mn	100	(33)
Fe	10	(33)
Ni	5	(1.7)
Cu	100	(33)
As	15	5
SO_4	100	(33)
Quartz	15	5

The 1/2 hour impingement value is basically a design criteria in engineering considerations for new plants. A general rule of thumb is that the 1/2 hour impingement value is set some 3 times higher than the 24 hour level. The values in brackets should thus be considered as estimates of what the applicable Ontario standard might be. The values not in brackets may be taken as a tentative standard sanctioned by the Ontario Ministry of Environment.

TABLE 6. TLV's THRESHOLD LIMIT VALUES SUGGESTED BY THE AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS [2] ($\mu g/m^3$)

	Concentration	Notes
Pb	150	
Zn	5,000	zinc oxide
Cr	50	as CrVI
Cd	50	ceiling limit
Mn	1,000	as fume
Fe	1,000	soluble salts
Ni	100	nickel sulphide
Cu	200	
As	200	
SO_4	1,000	per H_2SO_4
Quartz	100	pure

These guidelines refer to an occupational exposure of 8 hours per day, 5 days per week. The ceiling limit indicates that this value should not be exceeded even for short periods of time.

TABLE 7. ALLOWABLE ANNUAL AVERAGES FOLLOWING METHODOLOGY PROPOSED BY AN AD HOC COMMITTEE FOR TOXIC AIR CONTAMINANTS FOR THE MIDDLE ATLANTIC STATES SECTION OF THE AIR POLLUTION CONTROL ASSOCIATION[6] ($\mu g/m^3$) ANNUAL AVERAGE.

Pb	1.5*+
Zn	(119)
Cr	(.12)
Cd	(1.19)
Mn	(23.8)
Fe	(23.8)
Ni	(2.38)
Cu	(4.8)
As	.024*
SO_4	(23.8)
Quartz	(2.38)

*- specifically cited values. Values appearing in brackets were calculated using the TLV's of Table 6 as a base and dividing by a factor following the proposed methodology. Where more than one interpretation was possible, the most conservative approach was used.

+ - EPA Primary Standard averaged over a calender quarter.[12]

APPENDIX 2. AIR CONCENTRATIONS OF SPECIFIED POLLUTANTS IN OTHER AREAS

Results are reported in units of micrograms per cubic meter of air ($\mu g/m^3$) as a 24 hour average.

TABLE 8. CONCENTRATIONS FOUND IN OTHER AREAS OF MANITOBA.

St. Laurent (1976 June, July, August - 8 samples, rural background site)

	Average	Range
TSP	31.01	11.8 to 48.2
Cu	.052	.008 to .090
Cd	<.004	<.003 to .003
Pb	.064	.032 to .140
Ni	<.025	<.016 to .043
Mn	<.012	<.006 to .027
As	<.015	<.013 to .028

Table 8 cont'd

Carman (1976 June, July, August - 12 samples, intermediate site)

	Average	Range
TSP	96.07	40.2 to 189
Cu	.026	.012 to .049
Cd	<.003	<.003 to .003
Pb	.155	.063 to .228
Ni	<.018	<.014 to .042
Mn	.054	.015 to .124
As	<.013	<.013

Table 8 cont'd

Winnipeg (1979, 65 Ellen Street - urban site)

	No. of Samples	Geometric Mean	Range
TSP	61	72.7	14 to 391
Cu	61	.06	.019 to .215
Pb	61	.57	.18 to 7.28
As	60	.002	.0003 to .061
Cd	61	<.004	.003 to .061
Ni	61	<.020	.014 to .042
Cr	61	<.020	.014 to .021
Mn	59	.020	.006 to .242
SO_4	61	2.39	.19 to 9.32

Table 8 cont'd

Winnipeg (1980, 65 Ellen Street - urban site)

	No. of Samples	Geometric Mean	Range
TSP	53	73.12	15.3 to 441
Pb	53	.470	.170 to 2.03
Fe	52	1.25	.277 to 7.05
SO_4	52	--	.31 to 10.5
Cd	14	.002	<.001 to .002
Cr	14	.010	<.010 to .04
As	14	.001	.003 to .004

TABLE 9. VALUES FOUND IN THE RURAL U.K.

Results for Cd and Pb reported in nanograms per cubic meter (ng/m^3) as a 24 hour average. Results for SO_4 in micrograms per cubic meter ($\mu g/m^3$) as a 24 hour average.

1978 Program		Cd(ng/m^3)	Pb(ng/m^3)	SO_4($\mu g/m^3$)
Hazlerigg	Mean	1.9	228	6.71
(n=30)	Std. Dev.	2.1	157	6.39
	Range	.1 - 8.2	47 - 640	.28 - 21.6
Lancaster	Mean	3.33	3400	7.27
town Hall	Std. Dev.	3.07	2250	6.47
	Range	.3 - 14.8	540 - 7700	1.17 - 21.1
1979 Program				
Cockerham	Mean	2.00	178	6.01
(n=30)	Std. Dev.	1.55	94	5.44
	Range	.2 - 6.8	21 - 410	.3 - 22.9
Town Hall	Mean	2.04	4210	9.23
of	Std. Dev.	1.26	1540	7.70
Lancaster	Range	.5 - 4.9	1600 - 6900	1.07 - 33.1

APPENDIX 3. METEORLOGICAL DATA DURING SHERRIDON SURVEY.

Date	Sherridon Wx	Flin Flon Wx	Flin Flon Wind	Remarks	TSP
July 28	Rain AM			TS	
July 29			WNW 9		9
July 30	Cloudy		WSW 8		33
July 31	Rain		NE 7		10
Aug. 01	Cloudy		ESE 7		6
Aug. 02	R		ENE 9 Gusty	TN	4
Aug. 03	R		E 8		7
Aug. 04	R		SW 1	TS	14
Aug. 05	R		N 5		8
Aug. 06	Cloudy		SSW 2		14
Aug. 07	R		NW 12 Gusty		6
Aug. 08	Cloudy		N 10		5
Aug. 09	Cloudy		S 3	TN	11
Aug. 10	Clear		S 6		12
Aug. 11	Clear		S 9	TS	25
Aug. 12	Clear		S 7		17
Aug. 27	Cloudy R		WNW 5		14
Aug. 30	Cloudy R	R	SSW 1	TN	5
Aug. 31	Cloudy R	L - F	ENE 6		2
Sep. 01	Cloudy		SW 2	TS	11
Sep. 02	Cloudy R		WNW 3		15
Sep. 04	Cloudy		NNW 9 Gusty		6
Sep. 06	Cloudy		SSE 4	TN	6
Sep. 07	Cloudy		S 7		9
Sep. 08	Cloudy/Partly		NE 4	TS	15
Sep. 10	Clear		SE 7		8
Sep. 11	Cloudy		WSW10 Gusty		7
Sep. 12	Cloudy		NW 6		4
Sep. 13	Clear		NNW 6	TN	9
Sep. 14	Clear		SW 5 Gusty		15
Sep. 15	Cloudy		SW 10 Gusty	TS	9
Sep. 16	Clear		N 3		7
Sep. 17	Clear		S 4		8
Sep. 18	Cloudy		NW 13 Gusty		3
Sep. 19	Clear		NW 2		3
Sep. 20	Clear		SSW 4	TN	16
Sep. 21	Clear		SW 8		19
Sep. 22	Clear		WNW 4	TS	10
Sep. 23	Clear		N 4		19
Sep. 24	Clear		SSE 6		17
Sep. 25	Clear		S 5		4

Sep. 26	Clear		N 11 Gusty		--
Sep. 27	Clear		ENE 7	TN	3
Sep. 28	Cloudy R-pm		ENE 9 Gusty		3
Sep. 29	Cloudy/ Overcast	S-1P-R	N 12	TS	
Sep. 30	Overcast SW	R SW-	WNW 7		5
Oct. 01	Overcast am/ Clear pm		SSW10		2
Oct. 02	Overcast R	R - L	WSW 6		
Oct. 03	Partly Cloudy	S-SP-L	N 3		2
Oct. 04	Cloudy am/ Clear pm	S-	NNE11	TN	3
Oct. 05	Clear		S 3		3
Oct. 06	Clear		SE 6	TS	2
Oct. 14	Clear		WNW 4		
Oct. 15	Cloudy		WNW 4		6
Oct. 16	Cloudy S-	SW-	E 5		4

Flin Flon is approximately 40 miles from the Town of Sherridon with insignificant variation in elevation.
Wind direction is direction from which wind is blowing. Wind speed is reported in knots.

Clear	No Cloud	R = Rain
Partly Cloudy	1 - 5/10s	L = Drizzle
Cloudy	6 - 9/10s	SP = Snow Pellets
Overcast	10/10s	IP = Ice Pellets
		SW = Snow Showers

TN = Train Northbound - Possible increased traffic on road.
TS = Train Southbound - Possible increased traffic on road.

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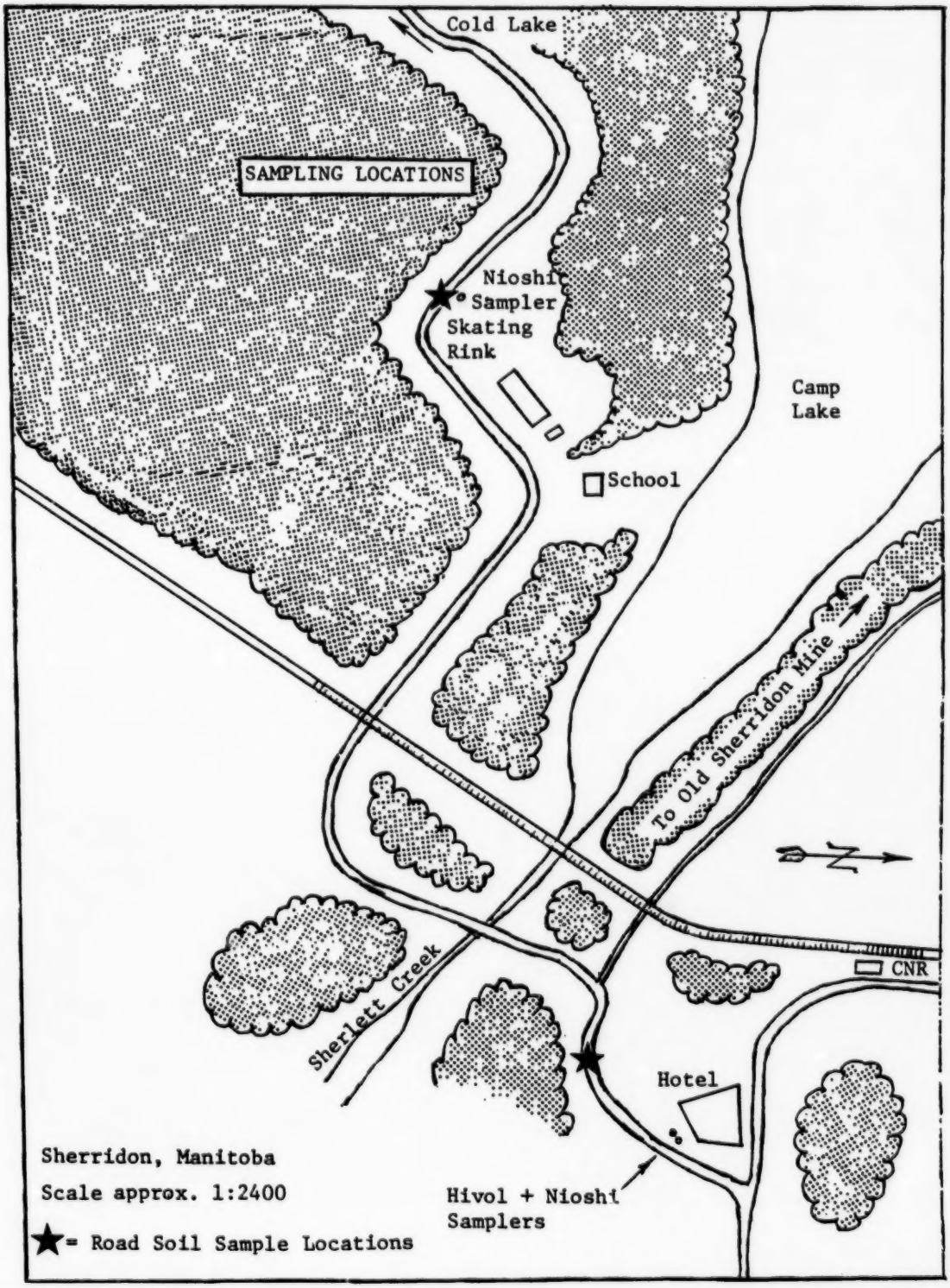
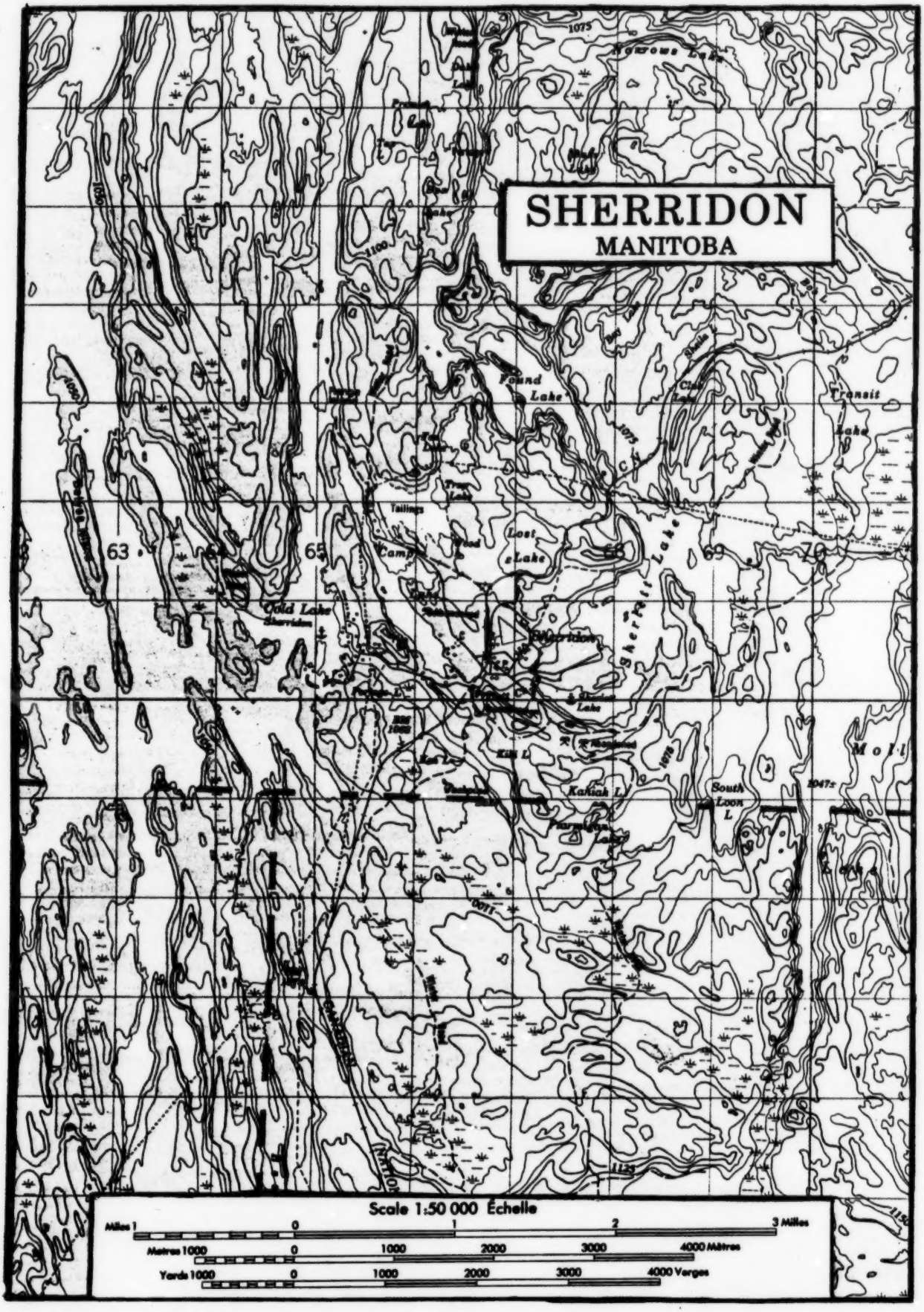

Cold Lake
SAMPLING LOCATIONS
Nioshi Sampler
Skating Rink
Camp Lake
School
To Old Sherridon Mine
CNR
Sherlett Creek
Hotel
Sherridon, Manitoba
Scale approx. 1:2400
= Road Soil Sample Locations
Hivol + Nioshi Samplers

Figure 1


SHERRIDON
MANITOBA
Scale 1:50 000 Échelle
Miles 1
0
1
2
3 Miles
Metres 1000
0
1000
2000
3000
4000 Metres
Yards 1000
0
1000
2000
3000
4000 Verges
Found Lake
Transit Lake
Tailings
Camp
Lost Lake
Sherratt Lake
Old Lake Sherridon
Sherridon
Kakiak L.
South Loon L.
Moll
63
65
69
70